Saskatchewan
Health

*Investing in your good health*

# The Epidemiology of Infant Mortality in Saskatchewan 1982 – 1996

**May 2000**

100-06918/

# THE EPIDEMIOLOGY OF INFANT MORTALITY IN SASKATCHEWAN, 1982 – 1996

**May 2000**

***Prepared by:***

***The Infant Mortality Research Team:***

***Dr. Lisa Lix***

***Felecia Watson***

***Dr. William Osei***

***Sharon Miller***

***Trish Macfarlane***

***Saskatchewan Health***

## Acknowledgements

The Infant Mortality Research Team at Saskatchewan Health would like to acknowledge the following individuals who contributed their time and expertise to the preparation of this report:

Lorena Rostie, Corporate Information and Technology Branch, Saskatchewan Health

Roy Gough, Acute & Emergency Services Branch, Saskatchewan Health

Dr. Shauna Hudson, Medical Services Branch, Health Canada

Shelley Gibson, Vital Statistics Unit, Saskatchewan Health

Leslie Rozon and Michelle Mallory

Rob Anderson, Corporate Information and Technology Branch, Saskatchewan Health

## Table of Contents


**EXECUTIVE SUMMARY** ..... 4

**INTRODUCTION** ..... 6

**METHODOLOGY** ..... 8

Definition of Terms ..... 8
Data Source ..... 8
Variables Derived from Death Registrations ..... 9
Merging Birth and Death Registrations ..... 10
Variables Derived from Birth Registrations ..... 11
Variables Describing Residence Location ..... 12
Data Analysis Techniques ..... 13

**RESULTS** ..... 15

**Major Characteristics of the Data** ..... 15

Identification of the Study Population ..... 15
Assessment of Data Quality ..... 15
Numbers of Deaths and Crude Infant Mortality Rates ..... 16

**Analysis of Variables from Death Registrations** ..... 19

Sex of Infant ..... 19
Age at Death ..... 20
Season of Death ..... 22
Cause of Death ..... 22

**Analysis of Variables from Birth Registrations** ..... 29

Maternal Age ..... 29
Length of Gestation ..... 31
Type of Birth ..... 32
Birth Weight ..... 32
Birth Weight Adjusted Infant Mortality Rates ..... 34

**Analysis of Regional Differences** ..... 35

Infant Mortality Rates for Saskatchewan Health Districts/Authority ..... 35
Regina and Saskatoon Comparisons ..... 38
Rural, Urban, and First Nations Comparisons ..... 39
Community of Residence ..... 41

**DISCUSSION AND CONCLUSIONS** ..... 43

**REFERENCES** ..... 47

**APPENDIX: CAUSES OF INFANT DEATH** ..... 49

## EXECUTIVE SUMMARY

Infant mortality rate (IMR) is a universal indicator of population health status[1]. It is widely regarded as the best single measure of general societal health and well being [2]. A high IMR in a population can be a reflection of deficiencies of physical and socio-economic factors such as nutrition, socio-economic status, education, or health care. IMR data are often used in health planning, evaluation, and policy development.

Infant Mortality Rates (IMRs) are calculated on a yearly basis, by counting all infant (age less than 12 months) deaths and dividing them by the number of all live births, then multiplying by 1000. They are expressed as infant deaths per 1000 live births.

This report describes trends in the numbers and types of infant deaths and their related factors in Saskatchewan for the 15-year period from 1982-1996.

Data on infant deaths and live births that occurred in the 15 year study period were obtained from death and birth registrations maintained by the Vital Statistics Unit of Saskatchewan Health.

A number of detailed analyses were conducted using information contained on the birth and death registrations including but not limited to infant sex, infant's age at death, cause of death, maternal age, birthweight, and length of gestation. Information on Registered Indian status, as recorded on the death registration, was also used in these analyses. Crude infant mortality rates were calculated for each year in the study and for each health district in the province.

In the 15-year period from 1982-1996, there were 2113 deaths of a live-born infant under one year of age that occurred within Saskatchewan to an infant whose normal place of residence was also in the province.

The number of infant deaths has decreased by over 39% during the period. Infant mortality rates in Saskatchewan have also decreased by over 12% since 1982. However, the rate of decline has slowed, and Saskatchewan presently has the highest rate among all of the Canadian provinces.

Important observations were made about infant deaths in Saskatchewan.

- More infant deaths occurred among male infants (57%).

- Forty percent of all deaths occurred in the post-neonatal period (after 28 days of life); this percentage increases to 70% for Registered Indian infant deaths.
- Perinatal conditions and congenital anomalies were the leading causes of death, together accounting for 59% of all infant deaths.
- The Registered Indian population had a higher percentage of infant deaths due to SIDS and 'Other' conditions, while the population excluding Registered Indians had a higher percentage of deaths due to perinatal conditions.
- The majority of mothers experiencing an infant death were under 30 years of age at the time of birth (76%).
- More than half (56%) of infant deaths that occurred to adolescent mothers (under 20 years of age) were reported in the Registered Indian population group.
- Over half (54%) of all infant deaths occurred among pre-term infants (infants born before the 37th week of gestation).
- More than half of Registered Indian infant deaths (54%) were of normal birth weight compared to only 32% of infant deaths in the rest of the Saskatchewan population.
- Athabasca Health Authority and Mamawetan Churchill River Health District had rates that were more than double the average provincial rate of 8.4 deaths per 1,000 live births.
- Greenhead Health District had the highest infant mortality rate among all the southern health districts, 13.0 deaths per 1, 000.
- Rates in the Registered Indian population were significantly higher than rates for the non-Registered Indian population.

This analysis of data on infant deaths in Saskatchewan is one step towards an increased awareness of the complexity of factors that contribute to infant health and the need to continue efforts to monitor those initiatives that may impact on infant health. It is hoped that this study will help to draw attention to the opportunities for prevention that do exist within the province. One infant death prevented equals one Saskatchewan family saved for the future.

# INTRODUCTION

Infant mortality rate (IMR) is a universal indicator of population health status[1]. It is widely regarded as the best single measure of general societal health and well being [2]. A high IMR in a population can be a reflection of deficiencies of physical and socioeconomic factors such as nutrition, socioeconomic status, education, or health care. IMR data are often used in health planning, evaluation, and policy development.

In developed countries, IMR has been declining over the past several decades[3,4]. However, the rate of decline has been slowing and disparities among socioeconomic groups are becoming more evident[5]. It has been noted that there are generally significant differences in the IMR between socioeconomic groups even in countries with low overall rates of infant mortality[6]. However, in countries where there is a more equitable distribution of resources, the differences between population groups tend to be smaller.

Within Canada, the national IMR has hovered close to 6 infant deaths per 1,000 live births for the past decade, although it dipped below this figure for the first time in 1996, to a value of 5.6 infant deaths per 1,000[7]. In Saskatchewan, both the total number of deaths and the provincial IMR have shown a decline over the past 15 years. However, the IMR for Saskatchewan remains high; it is currently the highest among all Canadian provinces (see Table 1). According to Statistics Canada, the IMR for Saskatchewan in 1997 was 8.9 infant deaths per 1,000 live births, which is significantly higher than the national rate of 5.5 infant deaths per 1,000 live births[8]. It is not well known what factors contribute to the Saskatchewan IMR. Given the existence of lower rates in other Canadian provinces, it should be possible to anticipate reductions in the Saskatchewan rate; an expectation of such progress necessarily begins, however, with a thorough examination of all facets of the issue.

**Table 1: Infant mortality rates for Canada and the Provinces, 1991-97[8]**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|
| **CANADA** | **6.1** | **6.1** | **6.3** | **6.3** | **6.1** | **5.6** | **5.5** |
| Newfoundland | 7.8 | 7.1 | 7.8 | 8.2 | 7.9 | 6.6 | 5.2 |
| Prince Edward Island | 6.9 | 1.6 | 9.1 | 6.4 | 4.6 | 4.7 | 4.4 |
| Nova Scotia | 5.7 | 6.0 | 7.1 | 6.0 | 4.9 | 5.6 | 4.4 |
| New Brunswick | 6.1 | 6.3 | 7.2 | 5.4 | 4.8 | 4.9 | 5.7 |
| Quebec | 5.9 | 5.4 | 5.7 | 5.6 | 5.5 | 4.6 | 5.6 |
| Ontario | 6.3 | 6.3 | 6.2 | 6.0 | 6.0 | 5.7 | 5.5 |
| Manitoba | 6.4 | 6.8 | 7.1 | 7.0 | 7.6 | 6.7 | 7.5 |
| **Saskatchewan** | **8.2** | **7.3** | **8.1** | **8.9** | **9.1** | **8.4** | **8.9** |
| Alberta | 6.7 | 7.2 | 6.7 | 7.4 | 7.0 | 6.2 | 4.8 |
| British Columbia | 6.5 | 6.2 | 5.7 | 6.3 | 6.0 | 5.1 | 4.7 |
| Yukon | 10.6 | 3.8 | 7.9 | 2.3 | 12.8 | - | 8.4 |
| Northwest Territories | 12.2 | 16.7 | 9.6 | 14.6 | 13.0 | 12.2 | 10.9 |

To date in Saskatchewan, no comprehensive studies of infant mortality rates and associated characteristics and risk factors have been conducted. Available information has been limited primarily to reporting of raw numbers with little or no investigation into associated risk factors, causes, regional differences, and changes over time. As well, while studies in other parts of Canada have noted potential inaccuracies or inconsistencies in the reporting of infant deaths [9,10,11], which also impacts on reported figures, this has not been investigated from a Saskatchewan perspective.

The primary purpose of this study, therefore, is to describe trends in the numbers and types of infant deaths in Saskatchewan for the 15-year period from 1982 to 1996, and to investigate the quality of available data. This is the first of two planned reports on infant mortality in Saskatchewan and the associated modifiable and non-modifiable risk factors. The next report will focus on a case-control study to investigate the relationship between infant mortality and selected infant, maternal, and environmental factors or characteristics.

# METHODOLOGY

## Definition of Terms

For this study, an infant death was defined as the death of a child under one year of age in Saskatchewan whose normal place of residence was also in the province. Thus, the study excluded infant deaths occurring outside of the province to residents of Saskatchewan, as well as those occurring within the province to non-residents of Saskatchewan. The first exclusion was undertaken to reduce the amount of missing data in the study; death registrations in other provinces may not include the same data fields as those in Saskatchewan. The second exclusion was made to reduce the inflation of IMRs that may occur by including out-of-province deaths. Thus, the results presented in this report may not correspond exactly with those found in other reports (e.g., Statistics Canada documents).

In order to calculate infant mortality rates for this study, it was also necessary to develop a working definition of a live birth. According to World Health Organization, a live birth is the "complete expulsion or extraction of the products of conception, irrespective of the duration of the pregnancy, which breathes or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord or definite movement of a voluntary muscle". For the purposes of this study, a live birth was further defined as a birth that occurred within the province to a mother who was a resident of Saskatchewan.

## Data Source

Data on all infant deaths meeting the criteria specified above were compiled for the 15-year period from 1982 to 1996 from death registrations maintained by the Vital Statistics Unit of Saskatchewan Health. Before 1998, Vital Statistics had housed this database in a mainframe application. In 1998, the Corporate Information and Technology Branch (CITB) of Saskatchewan Health assumed responsibility for managing this database; the data were subsequently converted into a more user-friendly microcomputer application.

To assess the reliability and quality of available data from both sources, the data compiled from Vital Statistics records and data reported by CITB were compared to actual death registrations that were manually abstracted. Because of the large volume of data that was available, this manual abstraction of data to assess quality and reliability was limited to two separate years, 1986 and 1996. Data from 1996 were abstracted because at the time of the study, it represented the more current year of available data. For comparison purposes, 1986 data were also selected for manual abstraction; different data reporting practices are likely to appear in two years as disparate in time as these.

Data on live births were also compiled for the study. These data were obtained from birth registration records maintained by the Vital Statistics Unit, from a database managed by CITB.

**Variables Derived from Death Registrations**

In the first phase of this study, a number of analyses were conducted using information contained on the death registration including sex of infant, infant's age at the time of death, month of death, and cause of death. Information on Registered Indian Status, as recorded on the death registration, was also used in these analyses.

The date, month, and year of both the death and birth of an individual are recorded on the death registration. This information was used to compile data on age at death. Data were grouped into two major age categories: neonatal (28 days or less) and post-neonatal (more than 28 days). The neonatal category was further subdivided into the following mutually exclusive categories: (a) up to one day of age (very early neonatal), (b) from one to seven days of age (early neonatal) and (c) from eight to twenty-eight days of age (late neonatal).

Variations in infant deaths were also investigated by grouping the data according to season of death. Spring was defined as the period from March to May; summer encompassed the months of June, July and August; fall was defined as the period from September to November; and winter encompassed the remaining months of December, January and February.

Causes of death were described according to the International Classification of Disease, 9$^{th}$ Edition (ICD-9). Each death registration contains a numeric ICD-9 code that

is used to describe the major factor contributing to death. Using this numeric code, each infant death was assigned to one of the following mutually exclusive categories: conditions arising in the perinatal period, congenital anomalies, Respiratory Distress Syndrome (RDS), Sudden Infant Death Syndrome (SIDS), injuries (unintentional and intentional), and *other*. These are commonly used categorisations for describing the major causes of infant death. A list of the ICD-9 codes that comprise each category, and a description of each category, can be found in the Appendix.

Registered Indians are those individuals who are nominated by a particular band and approved by the federal government as outlined under Section 6 of the *Indian Act*. Registered Indian status is an optional reporting field on the death registration. However, the Medical Services Branch of Health Canada verifies this data in order to increase the accuracy and consistency of data reporting. Data on deaths among Registered Indian members of the Saskatchewan population are provided in various sub-analyses contained within the report.

**Merging Birth and Death Registrations**

In the second component of this study, death registrations for the period from 1992 to 1996 were merged with birth registrations in order to investigate specific characteristics of the birth that may be associated with death of an infant. To increase the amount of data available for analysis and to improve the timeliness of this aspect of the study, data from 1997 were subsequently added to the database.

In Saskatchewan, each individual is assigned a unique health service number (HSN) at birth. However, the HSN is not always recorded on the birth registration in a timely fashion. Hence, it was not possible to use an individual's HSN to merge death and birth registration information. Rather, a more indirect matching technique was used.

The two databases were merged using a computer algorithm written using the SAS[12] statistical program. The algorithm searched for exact matches using the following key fields, as recorded on the death registration: last name of infant, day of birth, month of birth, and year of birth. Of the 575 infant deaths occurring between 1992 and 1996, only 82% could be matched to a birth registration using this algorithm. Hence, it was necessary to modify the algorithm in order to increase the number of matches. Further

investigation suggested that it would be necessary to use either the father's last name or the mother's last name, as recorded on the birth registration, to match against the last name of the infant as recorded on the death registration. The proportion of exact matches increased to 97% when this modification in the search criteria was made. Finally, a manual search process was used to match the remaining 3% of death registrations to the corresponding birth registration.

**Variables Derived from Birth Registrations**

A number of analyses of the data were conducted using information contained on the birth registration, including maternal age at the time of birth, length of gestation, type of birth (e.g., singleton, twins), and birth weight. It should be noted that complete details on birth characteristics are not available for all infant deaths. For example, some infants were born out of province, but later died in Saskatchewan as residents of this province; complete data were not available in such instances. The proportion of missing data was small, and should be viewed as having a non-significant impact on the results.

The birth month and birth year of the mother is recorded on the birth registration. This information was used to calculate maternal age at the time of birth. Since the mother's exact day of birth is not captured on an infant's birth registration, all calculations of maternal age at birth were performed using the 15$^{th}$ day of a month as the maternal day of birth.

The length of gestation is recorded in full, completed weeks on the birth registration. The gestation period represents the period from the date of conception to the date of birth; the former is determined either by using ultrasound methods or the day on which a woman's last menstrual cycle began. Pre-term births are defined as those births that occur before the 37th week of gestation, while post-term births are those that occur after the 41$^{st}$ week of gestation. All other births are classified as full-term births.

Birth weight is also captured on the birth registration. For this study, birth weight was provided in grams, and recorded to the nearest gram. Infant deaths were classified into the following categories using birth weight information: (a) low birth weight (LBW), which is defined as a birth weight of less than 2,500 grams; (b) normal weight, which is defined as a birth weight of 2,500 to 4,000 grams; and (c) high birth weight (HBW),

which corresponds to a weight of more than 4,000 grams. The LBW category can be further subdivided into the following: (a) extremely low birth weight (ELBW), which is a birth weight of less than 500 grams; (b) very low birth weight (VLBW), which corresponds to a weight of 500 to 1,499 grams; and (c) moderately low birth weight (MLBW), which represents a birth weight of 1,500 to 2,499 grams.

Using birth weight information, crude annual IMRs were re-calculated adjusting for the number of ELBW births, based on techniques described by Joseph[1] and Svenson et al.[13]. These birth weight-adjusted rates were then compared to the crude rate. This method of adjusting the IMR for ELBW babies has been suggested as a technique for producing more stable rates across time. It takes into account information about the viability of a live birth and may help to counteract the effects that changing definitions of live and still births have on the calculation of IMRs.

**Variables Describing Residence Location**

In the third component of this study, residence location information at the time of death, as recorded on the death registration, was used to describe differences in the numbers and types of infant deaths for various regions of the province and types of communities. This analysis was primarily undertaken for the most recent period of the study, that is, from 1992 to 1996 (or 1997), although some analyses are reported for the entire fifteen-year period from 1982 to 1996.

Each infant death was assigned to one of Saskatchewan's health districts/authority using residence information contained on the death registration. Each death can be associated with a single residence code, a five-digit numeric code that uniquely identifies each city, town, village, rural municipality (RM) and First Nation in Saskatchewan. Residence codes can be grouped into health districts. Cities, towns, and villages are all assigned to a single health district. However, some RM's fall into more than one health district. When this happens, the RM is apportioned among districts, such that a RM's population is divided among districts in proportion to the RM's land area. This can result in fractional values for the total number of infant deaths; figures were subsequently rounded to the nearest whole number. There is no RM structure in northern Saskatchewan; northern communities are assigned residence codes in a slightly different

manner. Using residence code information and the assignment of infant deaths to individual health districts/authority, it was possible to calculate crude IMRs for each health district/authority; this was undertaken for the most recent five-year period of the study only.

Furthermore, each infant death was assigned to one of three mutually exclusive residence categories using residence code information: urban, rural, and First Nations. Urban areas were defined as all cities and towns in a Saskatchewan, with a residence code in which the fourth digit was 2 or 3. First Nations are identified by residence codes that begin with a 7; each residence code corresponds to a single First Nations, but not a single reserve, as more than one land area might be owned by a First Nation. All remaining residence codes were assigned to the *rural* category; this will include most northern communities, other than northern First Nations. A comparison of the number and types of deaths occurring in each of these residence categories was also undertaken for the period from 1992 to 1997. Because of the large number of deaths occurring to residents of the urban centres of Regina and Saskatoon, a separate analysis was conducted for these two cities.

**Data Analysis Techniques**

The data are presented using a variety of descriptive and inferential techniques appropriate for categorical and continuous variables. Descriptive statistics include percentages, ratios, means, and standard deviations (std. dev.). The chi-square test of independence is used to assess the statistical association between categorical variables. The contingency coefficient, a measure of association, is used to describe the strength of the relationship between categorical variables[14]. The contingency coefficient can range in value from zero to one, with a contingency coefficient of zero indicating no association between variables and larger values indicating increasingly stronger relationships. The contingency coefficient provides information that can not be obtained from a test of statistical significance; it conveys information about the strength of the phenomenon under investigation. Tests of statistical significance tend to be strongly influenced by the number of observations available for analysis, unlike the contingency coefficient. Thus,

the contingency coefficient can be used to assess the practical, or substantive, significance of variable associations.

Crude IMRs and birth weight-adjusted IMR are presented graphically and also analyzed statistically using trend analysis techniques. With the latter method of analysis, the $R^2$ statistic, which represents the proportion of variation explained using a particular statistical model, is used to compare differences in the goodness of fit of trend models.

Comparisons among district-specific IMRs are assessed using the small area inferential analysis techniques described by Carriere and Roos[15]. These district comparisons were made using the overall provincial IMR as the comparison value. As well, health district results are presented using geographic mapping methods.

Tests of differences in regional results are conducted using either the chi-square tests, or one-way analysis of variance (ANOVA) techniques. The latter method is adopted in those instances where the dependent variable of interest is continuous in nature and the independent variable is categorical in nature. The $R^2$ statistic is used to describe the proportion of variation explained by an independent variable in an ANOVA model.

All tests of statistical significance have been conducted using the $\alpha = 0.05$ level of significance.

# RESULTS

## Major Characteristics of the Data

### Identification of the Study Population

In the 15-year period from 1982 to 1996, 2191 infant deaths were registered in Saskatchewan. A closer examination of this data resulted in the following exclusions: 36 death registrations were excluded from the study because an analysis of the dates of birth and death indicated an age of more than one year at time of death; another 42 records were excluded because the place of residence recorded on the death registration was from outside of the province. These exclusions resulted in a final study population of 2113 infant deaths.

### Assessment of Data Quality

Given the large volume of data that are maintained in any vital statistics registry system, it is likely that some errors will occur in the collection and recording of information. From the manual examination of the death registration registrations conducted for the two separate years of the study, 1986 and 1996, the following major points were observed.

First, as noted above in the aggregation of data, not all of the death registrations assigned to infants were actually for children who were under one year of age at the time of death. This may have occurred because of errors in the recording of either the date of birth or the date of death.

Second, it was noted that the diagnoses on death registrations were often imprecise and did not always adequately reflect the true cause of death. Persons completing the death registrations may not always have access to complete clinical information, including pathology and autopsy reports, necessary for the accurate identification of cause of death.

In general, however, the data recorded on death registrations were found to have a high degree of accuracy and completeness. There were no major differences in results for the quality assessments performed on the 1986 and 1996 data.

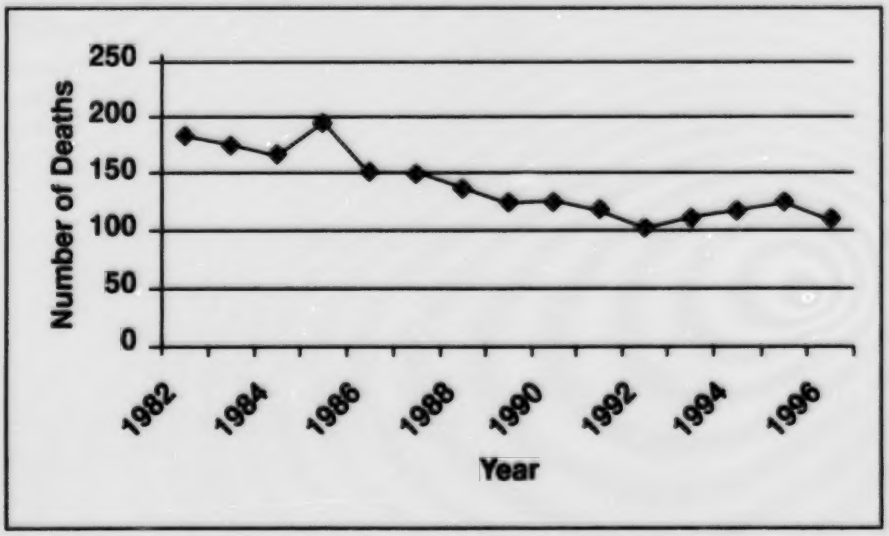
**Numbers of Deaths and Crude Infant Mortality Rates**

Initially, the infant deaths were grouped into three 5-year time periods to facilitate the examination of major trends in infant deaths that have occurred over time. These five-year time periods are used throughout this section of the report to convey the findings of the analyses. However, in selected instances, results are reported for individual years within the 15-year study period.

The total number of infant deaths was compared across the three 5-year time periods of the study. From 1982 to 1986, there were 873 deaths (41%). From 1987 to 1991, there were 665 (31%) and the remaining 575 deaths (27%) occurred during the period from 1992 to 1996.

Figure 1 provides information on the number of deaths occurring on an annual basis between 1982 and 1996. This figure reveals that, in general, the total number of deaths in Saskatchewan has been declining. However, a slight increasing trend was evident between 1992 and 1995.

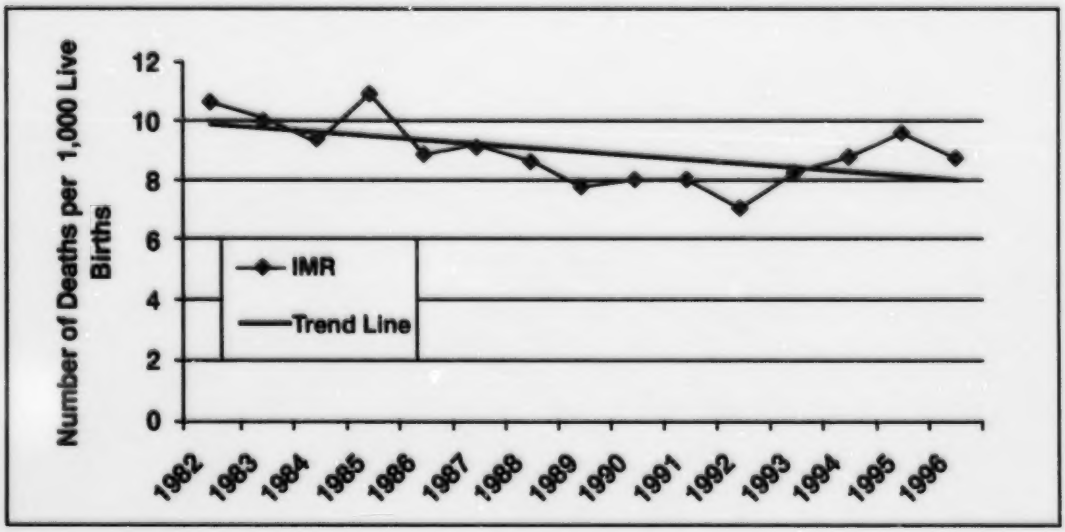
**Figure 1: Annual Number of Infant Deaths in Saskatchewan, 1982-1996**



Next, crude IMRs were calculated for each year within the study period. A crude rate is calculated as the total number of deaths in a given year divided by the number of live births in the same time period, and is expressed as a rate per 1,000 live births. Figure 2 reveals that the annual IMR has fluctuated slightly over the 15-year period, from a high of 10.9 deaths per 1,000 live births in 1985, to a low of 7.1 deaths per 1,000 live births in 1992.

A linear trend line was fitted to the annual crude IMRs. This trend line has a slope of -0.14, which suggests an overall modest decrease in IMRs. However, the degree of discrepancy between the estimated trend line and the actual plotted points is quite substantial in some years, most notably in 1985, 1992, and 1995. In fact, the linear trend line explains only 33% of the variation in the annual IMRs, and thus does not provide a very good fit to the data.

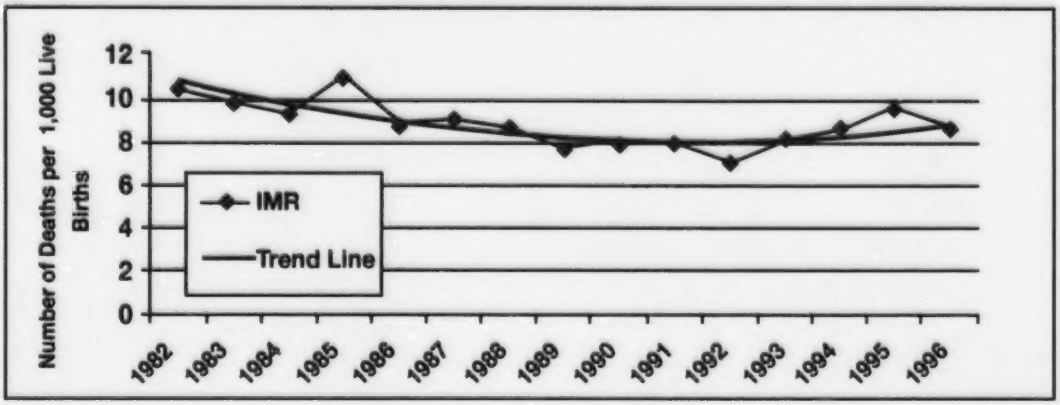
**Figure 2: Crude IMRs for Saskatchewan and Linear Trend Line, 1982-1996**




A second-order polynomial trend line was subsequently fitted to the data after a visual review of the characteristics of the data. This curvilinear trend line, which is depicted in Figure 3, suggests a slight increasing trend in the crude IMR in Saskatchewan, as a consequence of the slightly higher rates observed between 1993 and

1995. This comes after a period of decline and then relative stability in IMRs. This curvilinear line accounts for 66% of the variation in annual IMRs, and thus offers an improved fit over the linear trend line.

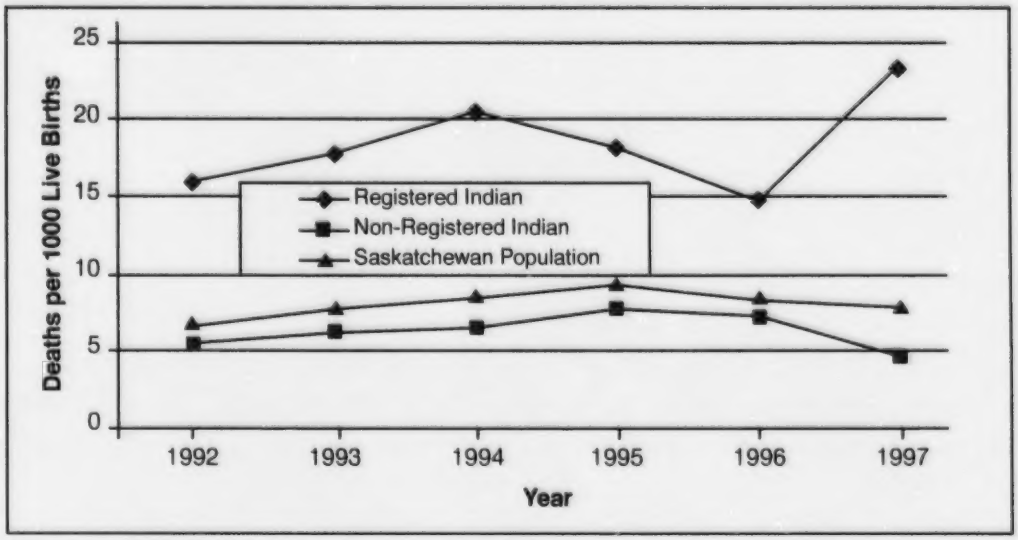
**Figure 3: Crude IMRs for Saskatchewan and Curvilinear Trend Line, 1982-1996**




While a comparison of the previous two figures suggests different trends in the results, a number of points are apparent based on the data obtained for this 15-year time period. Crude IMRs in Saskatchewan dropped a significant amount in the 11-year period between 1982 to 1992. This was followed by a period of instability; crude IMRs for Saskatchewan increased between 1993 and 1995, before decreasing again in 1996. This pattern has some similarities to those trends identified in other provinces. For example, Table 1 reveals that Manitoba's rate increased from 6.8 deaths per 1,000 live births in 1992 to 7.6 per 1,000 in 1995. Alberta's rate also increased between 1993 and 1994, from 6.7 per 1,000 to 7.4 per 1,000.

A comparison of IMRs for the Registered Indian, non-Registered Indian and provincial populations for the years 1992-1997 appears in Figure 4. Rates among the Registered Indian population were significantly higher than rates for the Non-Registered Indian population in each year ($p<0.05$). The difference in rates between the two populations decreased slightly in 1996 and then increased substantially in 1997. In 1997, the infant mortality rate for the Registered Indian population was 23.0, compared to 4.3 for the non-Registered Indian population and 7.6 for the Saskatchewan population.

**Figure 4: IMRs of Registered Indian, Non-Registered Indian and Provncial Population, 1992-1997**




## Analysis of Variables from Death Registrations

### Sex of Infant

Of the 2113 infant deaths occurring in the 15-year period of the study, 57% were male. The ratio of male to female deaths for the entire time period was 1.32:1, and the sex-specific death rates were 9.9 per 1,000 live births for males and 7.9 per 1,000 for females.

Differences in the number of deaths among male and female infants were examined for each of the three 5-year time periods of the study. Of the 873 infant deaths occurring in 1982-1986, 56% occurred among male infants, giving a male to female ratio of 1.27:1. Between 1987 and 1991, there were 665 infant deaths, of which 58% were attributed to male infants. In this five-year period, the male to female ratio was 1.38:1. Finally, 57% of the 574 deaths that occurred between 1992 and 1996 were for male infants, giving a male to female ratio of 1.32:1.

The ratio of male to female infant deaths for Canada has remained close to 1.3:1 in recent years[7]. Thus, the results obtained for Saskatchewan are similar to those obtained nationally.

**Age at Death**

Of the 2113 infant deaths that occurred between 1982 and 1996, 40% occurred in the post-neonatal period, that is, after the 28th day of life. Among those deaths in the neonatal period, the greatest proportion (47%) occurred in the very early neonatal period, that is, before the end of the first day of life (see Table 2).

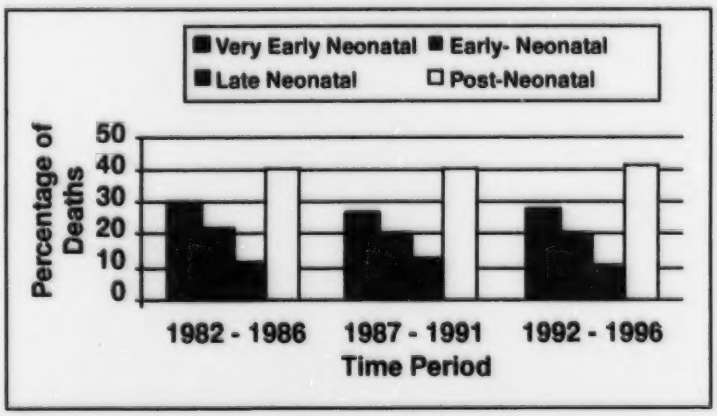
A chi-square test ($c^2 = 1.10$; $p = 0.78$) revealed that there were no statistically significant differences between male and female infants in their age at death; data on the number of infant deaths occurring in each age category are presented in Table 2. The most substantial of these small differences was for the late neonatal time period; 10% of male infants died during this period, compared with 12% of females.

**Table 2: Number of Infant Deaths by Sex and Age at Death, 1982-1996**

| | *Very Early Neonatal* (< 1 day) | *Early neonatal* (1 - 7 days) | *Late neonatal* (8 - 28 days) | *Post Neonatal* (29 - 364 days) | *Total* |
|---|---|---|---|---|---|
| *Male* | 336 | 255 | 123 | 487 | 1201 |
| *Female* | 256 | 189 | 106 | 361 | 912 |
| *Total* | 592 | 444 | 229 | 848 | 2113 |

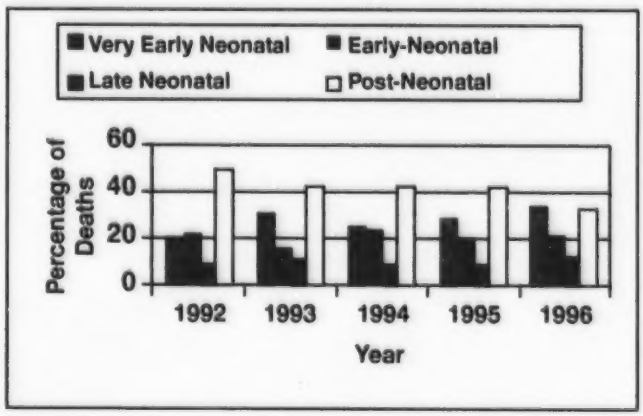
As shown in Figure 5, only minor differences in age at death were observed across the three time periods of the study. In each 5-year period, more infant deaths occurred in the post-neonatal period than in any of the other three categories of age at death; this proportion increased a non-significant amount over time, from 39% in 1982-1986 to 41% in 1992-1996.

**Figure 5: Age at Death by Five-Year Time Period, 1982-1996**



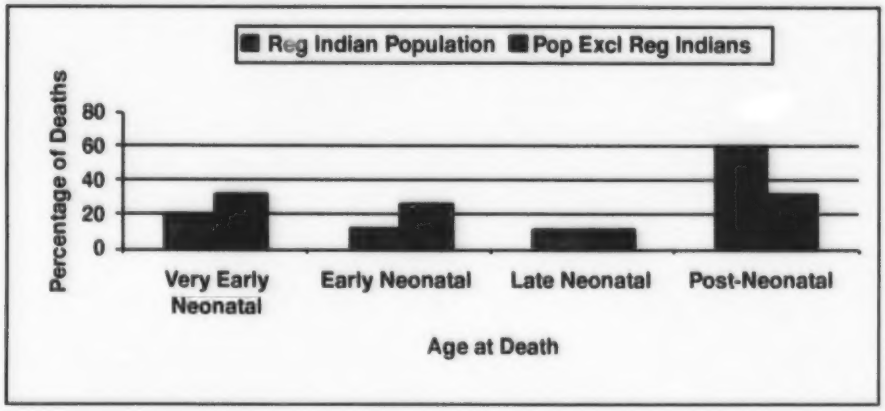
However, a closer inspection of the data for the most recent five-year period of the study revealed a slightly different pattern of results (Figure 6). The percentage of deaths occurring among the oldest infants (i.e., more than 28 days old) showed a decrease, from 49% of all deaths in 1992 to 33% in 1996. There was an overall increase in the percentage of deaths to infants less than one day old, from 19% in 1992 to 34% in 1996, although some fluctuation did exist in the intermediate years.

**Figure 6: Annual Results for Age at Death, 1992-1996**




A comparison of infant age at the time of death was undertaken for both the Registered Indian population and the population excluding Registered Indians (see Figure 7). This analysis, which was also undertaken for the five-year period from 1992 to 1996, revealed distinct differences across these two segments of the Saskatchewan population. The majority of deaths of Registered Indian infants (59%) occurred in the post-neonatal period. Only 20% of infant deaths for this population group occurred in the very early neonatal period. Among the remaining population of infant deaths, 32% of deaths occurred in each of the very early neonatal and post-neonatal periods.

**Figure 7: Age at Death for Registered Indian Infants, 1992-1996**




**Season of Death**

There were only minor, non-significant differences in the number of infant deaths across the four seasons. In fact, the total number of infant deaths was almost evenly distributed amongst the seasons. This result was apparent for the entire 15 years of the study, as well as for individual five-year segments. As well, there were only minor differences in age at death across the four seasons; a chi-square test revealed no significant association between these two variables.

**Cause of Death**

For the entire 15-year period of the study, perinatal conditions and congenital anomalies were the leading causes of death, together accounting for a total of 59% of all infant deaths. The *other* category, which includes infectious and parasitic diseases, cancer, and conditions of the respiratory system, were responsible for 16% of all deaths. SIDS was reported to be the cause of death for 14% of death registrations. The remaining 11% of all deaths were attributed to Respiratory Distress Syndrome (RDS) and to unintentional and intentional injuries.

Figure 8 depicts changes in the investigated causes of death across the three 5-year periods of the study. All causes showed a decrease in numbers over time, with the notable exception of Sudden Infants Deaths Syndrome (SIDS). There was a 24% increase in the number of SIDS deaths between the periods from 1982 to 1986 and from

1987 to 1991; the number of deaths increased from 95 to 118. There was a subsequent sharp decrease in the number of SIDS deaths; 86 deaths were reported between 1992 and 1996. The number of infant deaths due to congenital anomalies decreased by 33% from 246 (1982-1986) to 165 (1992-1996). Deaths due to RDS decreased by 78%, from 97 (1982-1986) to 21 (1992-1996). Deaths attributed to perinatal conditions decreased by 28%, from 260 (1982-1986) to 188 (1992-1996). As Table 3 reveals, all causes of death showed statistically significant decreases, with the exception of SIDS and injuries. As reflected in the numeric values of the contingency coefficient, RDS was associated with the largest decrease over time.

**Figure 8: Cause of Death by 5 Year Period, 1982-1996**

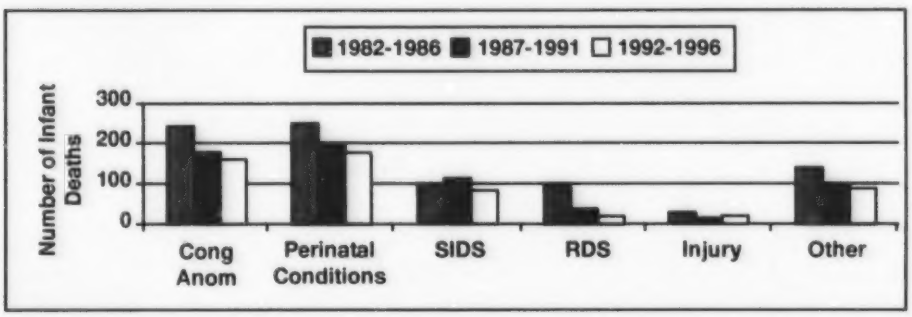



**Table 3: Changes in Number of Infant Deaths for Specific Causes over Time**

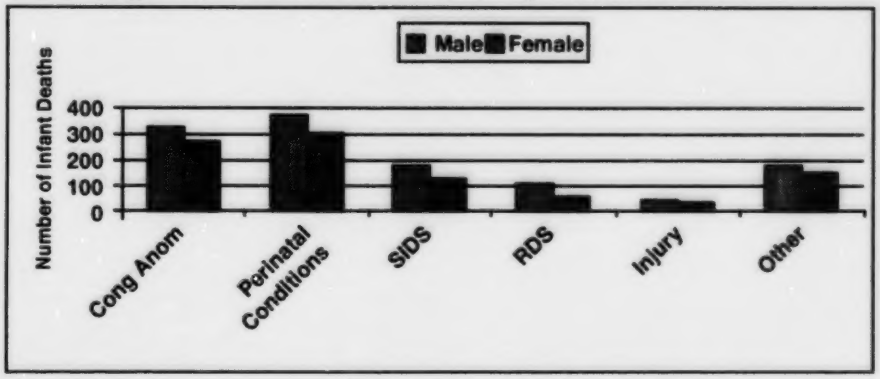
| | ***Chi-square Statistic*** | ***p-Value*** | ***Contingency Coefficient*** |
|---|---|---|---|
| *Congenital Anomalies* | 18.27 | 0.0001 | 0.17 |
| *Perinatal Conditions* | 12.52 | 0.0019 | 0.14 |
| *SIDS* | 5.46 | 0.0651 | 0.13 |
| *RDS* | 57.76 | <0.0001 | 0.52 |
| *Injury* | 3.49 | 0.1744 | 0.21 |
| *Other* | 15.06 | 0.0005 | 0.21 |

At the same time, the ranking of the various causes of death did not change substantially within each of the time periods of the study. Congenital anomalies accounted for approximately 28% of deaths in each period. Similarly, perinatal conditions accounted for approximately 30% of all deaths, and O*ther* conditions for approximately 15%. However, because of the significant decrease in the number of

deaths due to RDS, this cause accounted for the same number of deaths as injuries in the five years from 1992 to 1996.

Differences in causes of death for males and females were also investigated. As expected, males had a consistently higher number of deaths than females for all causes (see Figure 9). The greatest difference was for RDS, where males died at almost twice the rate of females. The difference was also substantial for SIDS; the number of male infant deaths due to SIDS was 50% higher than the number of female deaths. However, for both males and females, the most important causes of death were congenital anomalies and conditions arising in the perinatal period.

**Figure 9: Causes of Infant Death by Sex, 1982-1996**




Cause-specific death rates were higher for males than for females in all instances; however, these differences were only statistically significant for perinatal conditions, RDS and SIDS (see Table 4). As the magnitude of the contingency coefficient indicates, the most substantial difference was for RDS.

**Table 4: Cause-specific Infant Death Rates by Sex, 1982-1996**

| | ***Male*** | ***Female*** | ***Chi-square Statistic*** | ***p-Value*** | ***Contingency Coefficient*** |
|---|---|---|---|---|---|
| *Congenital Anomalies* | 2.7 | 2.4 | 4.55 | 0.13 | 0.09 |
| *Perinatal Conditions* | 3.1 | 2.5 | 10.98 | 0.007 | 0.12 |
| *SIDS* | 1.5 | 1.0 | 0.85 | <0.001 | 0.09 |
| *RDS* | 0.9 | 0.5 | 12.5 | 0.002 | 0.34 |
| *Injury* | 0.3 | 0.3 | 0.81 | 0.39 | 0.16 |
| *Other* | 1.5 | 1.3 | 5.44 | 0.16 | 0.19 |
| *Overall Rate* | 9.9 | 7.9 | 39.82 | <0.001 | 0.13 |

Differences between males and females in causes of death were also examined across the three time periods of the study. For all causes, more deaths were recorded for males than for females, with the exception of injuries in 1982-1986. Between 1982 and 1986, the greatest difference between male and female infants was for RDS, where the number of male deaths was more than twice the number of female deaths. There were also substantial differences between males and females for those causes of death included in the *other* category. Between 1987 and 1991, there were almost three times as many injuries for males as for females, although because of small numbers of events, this result should not be considered statistically reliable. In this same time period, substantial differences in numbers of deaths for males and females were also observed for RDS and conditions arising in the perinatal period. During the last five-year period of the study, the greatest differences were observed for SIDS, RDS, and injury, although the number of events in the latter two categories is too small to enable reliable comparisons.

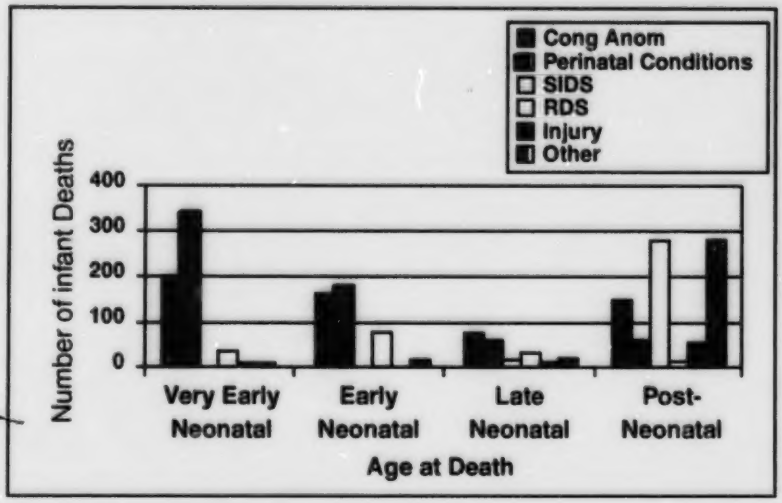
**Table 5: Infant Deaths By Cause, Gender and Time Period, 1982-1996**

| | *Sex* | *1982-1986* | *1987-1991* | *1992-1996* | *Total* |
|---|---|---|---|---|---|
| *Congenital Anomalies* | *Male* | 127 | 100 | 96 | 323 |
| | *Female* | 119 | 83 | 69 | 271 |
| | *Total* | 246 | 183 | 165 | 594 |
| *Perinatal Conditions* | *Male* | 142 | 128 | 101 | 371 |
| | *Female* | 118 | 81 | 87 | 286 |
| | *Total* | 260 | 209 | 188 | 657 |
| *SIDS* | *Male* | 52 | 71 | 56 | 179 |
| | *Female* | 43 | 47 | 30 | 120 |
| | *Total* | 95 | 118 | 86 | 299 |
| *RDS* | *Male* | 66 | 26 | 13 | 105 |
| | *Female* | 31 | 16 | 8 | 55 |
| | *Total* | 97 | 42 | 21 | 160 |
| *Injury* | *Male* | 13 | 14 | 13 | 40 |
| | *Female* | 18 | 5 | 8 | 31 |
| | *Total* | 31 | 19 | 21 | 71 |
| *Other* | *Male* | 86 | 47 | 50 | 183 |
| | *Female* | 58 | 47 | 44 | 149 |
| | *Total* | 144 | 94 | 94 | 332 |

Next, cause of death was investigated for its relationship to an infant's age at death. As shown in Figure 10, for the entire 15-year period of the study, perinatal deaths

were primarily due to congenital anomalies and conditions arising in the perinatal period. Early neonatal deaths were largely a result of perinatal conditions, congenital anomalies, and RDS. Late neonatal deaths can not be strongly associated with a single major cause, although congenital anomalies and perinatal conditions had higher frequencies than other causes. Major causes of infant death in the post-neonatal period were SIDS, injury, and *other* conditions; the latter included pneumonia and meningitis.

**Figure 10: Causes of Death by Age Category, 1982-1996**




Differences in cause of death as a function of age were also investigated across the three 5-year periods of the study. These results are presented in Figures 11 through 13.

Figures 11 through 13 indicate that for the three time periods, approximately 60% of deaths attributable to congenital anomalies occurred by the end of the first week of life. Similarly, across all three phases of the study, approximately 80% of deaths attributable to conditions arising in the perinatal period occurred by the end of the first week of life. Only about 20% of RDS deaths occurred in the very early neonatal period in either 1982-1986 or 1987-1991; in contrast, 40% of RDS deaths occurred in the very early neonatal period in 1992-1996. The vast majority (90%) of infant deaths attributed to SIDS occurred in the post-neonatal period. Similarly, infant deaths due to injury and

other conditions were more common in the post-neonatal period than in any other age category.

**Figure 11: Causes of Death by Age Group, 1982-1986**

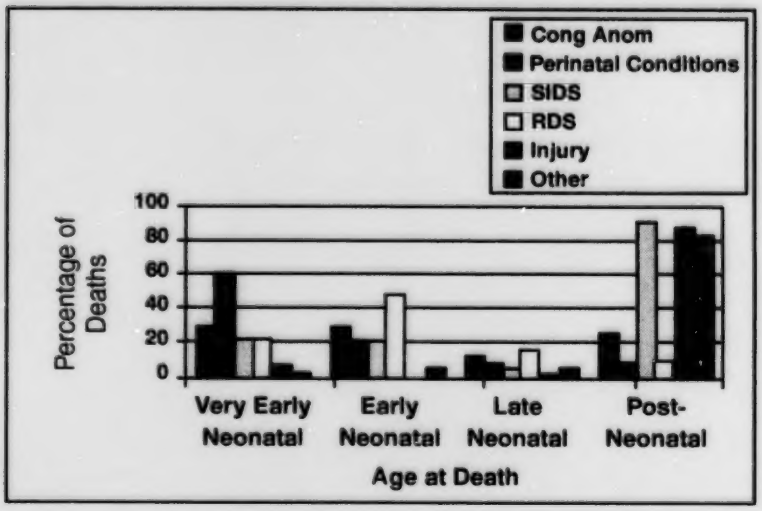



**Figure 12: Causes of Death by Age Group, 1987-1991**

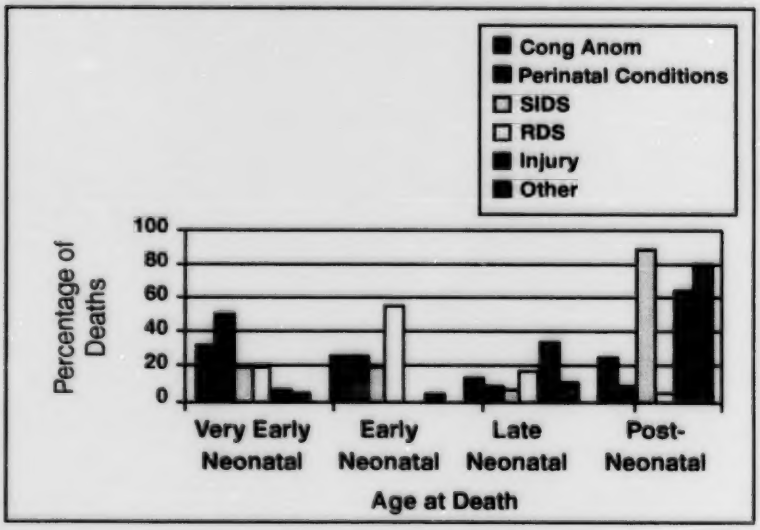
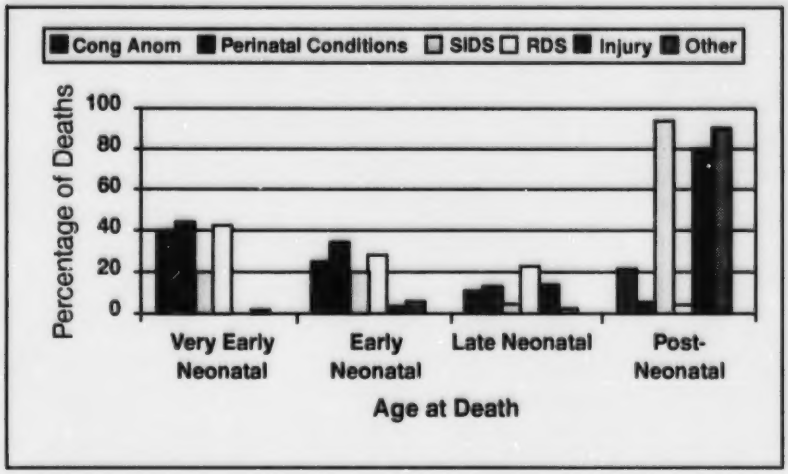


**Figure 13: Causes of Death by Age Group, 1992-1996**




Next, seasonal differences in the causes of death were examined. In general, few differences in the major causes of death were noted across the four seasons (see Table 6); a chi-square test ($c^2 = 21.0$; $p = 0.137$) revealed no statistically significant association between these two variables. However, there were slightly increased numbers of deaths due to SIDS in the spring (31%) and winter (29%) as compared with the summer (20%) or fall (21%). Deaths due to RDS and *other* conditions were slightly more common in the winter (30% and 29%, respectively) compared with other seasons of the year.

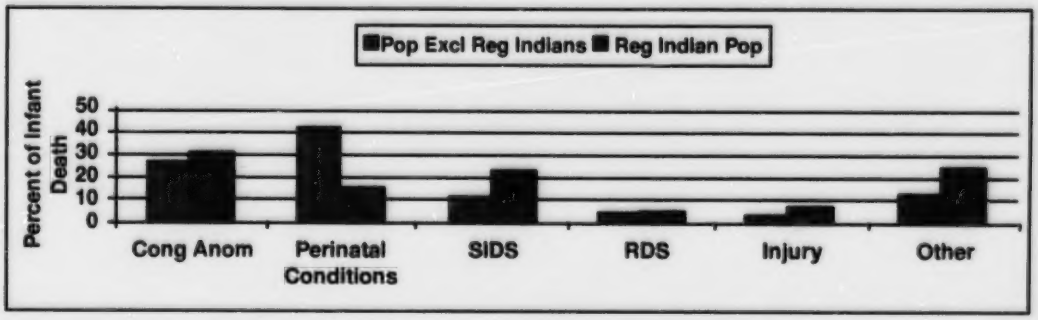
**Table 6: Number of Infant Deaths by Cause and Season, 1982-1996**

| | *Spring* | *Summer* | *Fall* | *Winter* | *Total* |
|---|---|---|---|---|---|
| *Congenital Anomalies* | 150 | 163 | 143 | 138 | 594 |
| *Perinatal Conditions* | 180 | 158 | 152 | 167 | 657 |
| *SIDS* | 92 | 60 | 62 | 85 | 299 |
| *RDS* | 39 | 40 | 33 | 48 | 160 |
| *Injury* | 17 | 17 | 22 | 15 | 71 |
| *Other* | 69 | 81 | 85 | 97 | 332 |
| *Total* | 547 | 519 | 497 | 550 | 2113 |

Because there were marked differences in age at death for Registered Indian infants as compared with infants in the rest of the Saskatchewan population, it was of

interest to investigate whether this resulted in differences in major causes of death. This investigation was undertaken for 1992 to 1996 only. As Figure 14 reveals, the distribution of causes of death in the two groups differed substantially. For Registered Indian infant deaths, congenital anomalies were the leading cause of death (30%), followed by other causes (24%) and SIDS (22%). For the remaining infant deaths in this 5-year period, perinatal conditions were the leading cause of death (42%), followed by congenital anomalies (29%), and other causes (12%). RDS accounted for a similar proportion of deaths in each segment of the population.

**Figure 14: Causes of Infant Death by Registered Indian Status, 1992-1996**




## Analysis of Variables from Birth Registrations

For the analyses conducted on the merged birth and death registrations, infant deaths from 1997 were combined with those from 1992 to 1996. There were 107 deaths in this year, bringing the total number of infant deaths available for analysis to 682. All analyses reported in this section of the report are based on this population size. In most cases, two years of data are combined when reporting results as a function of time; this helps to reduce the effect of small annual numbers of deaths and the inherent variability that is likely to exist for certain analyses.

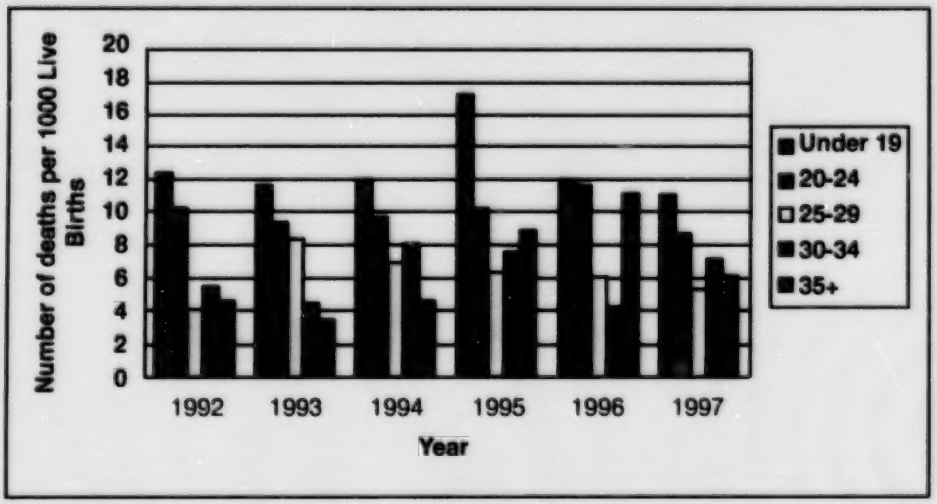
### Maternal Age

The mean maternal age for infants who died between 1992 and 1997 was 26 years (std. dev. = 6), with a range of 32 years. The majority of mothers experiencing an infant

death in this period were under 30 years of age at the time of birth (76%). Only 7% were 35 years of age or older.

Of those women who were under 30 years of age, almost one third (31%) were adolescents (under 20 years of age). The highest infant mortality rates occurred in this age group for every year in the study period (Figure 15). The mean age of adolescent mothers represented in the study population was 18 years (std. dev. = 1.4 years). Less than five deaths in this 6-year period occurred to mothers who were under 15 years of age.

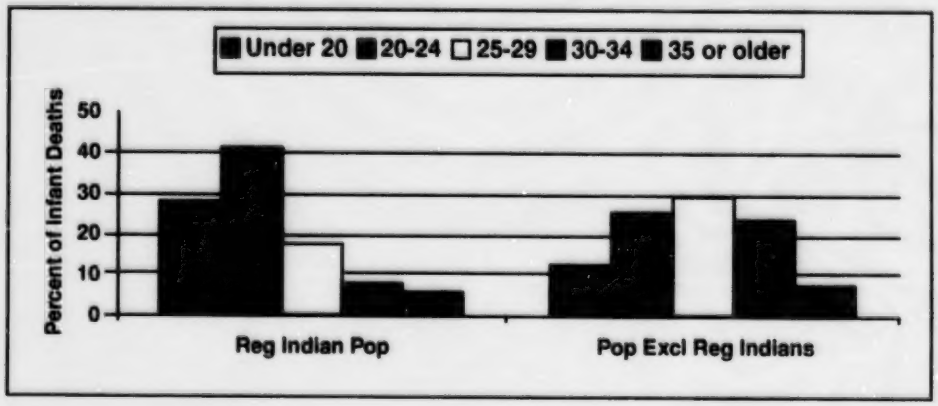
**Figure 15: Infant Mortality Rates by Maternal Age**




For adolescents, more than half of all infant deaths occurred in the post-neonatal period. In comparison, infant deaths among older women were more likely to occur in the neonatal period. For example, among those women who were 30 to 34 years of age, only 26% of infants died in the post-neonatal period, while 37% died in the very early neonatal period. This result is due to the higher proportion of Registered Indian infants who were born to adolescent mothers; more than half (56%) of those infant deaths that occurred to adolescent mothers were attributed to this Registered Indian population group. As noted in the previous section, Registered Indian infants were more likely to die at older ages

than infants in the rest of the Saskatchewan population were. Figure 16 provides information on the distribution of maternal age as a function of ethnicity of the mother.

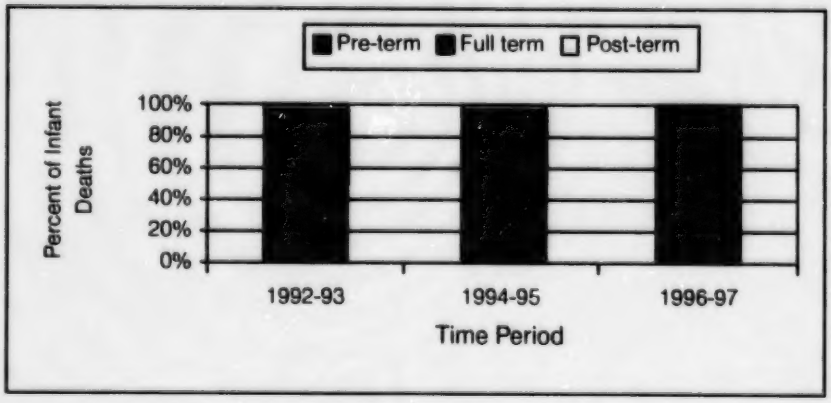
**Figure 16: Maternal Age for Infant Deaths by Registered Indian Status, 1992-1997**




**Length of Gestation**

For the period from 1992 to 1997, over half (54%) of all infant deaths occurred among pre-term infants, that is, infants who were born before the 37th week of gestation. Only 2% of deaths were for post-term infants, that is babies who were born after the 41st week of gestation. The proportion of pre-term infants increased slightly over the period of this study, from 50% in 1992-1993 to 59% in 1996-1997 (see Figure 17).

**Figure 17: Length of Gestation for Infant Deaths, 1992-1997**



Pre-term infant deaths were more common among older women. Three quarters of all infant deaths occurring to women who were 35 years of age or older were among babies born prematurely. In contrast, only 54% of deaths occurring to women who were between 20 and 34 years of age were for pre-term infants.

The majority of deaths of pre-term infants were due to conditions arising in the perinatal period (51%). Another 29% of pre-term infant deaths were a result of congenital anomalies. For full-term infant deaths, 31% were a result of congenital anomalies, and 26% were attributed to SIDS. For the small number of post-term infant deaths, SIDS, congenital anomalies, and O*ther* causes were equally common (27%).

**Type of Birth**

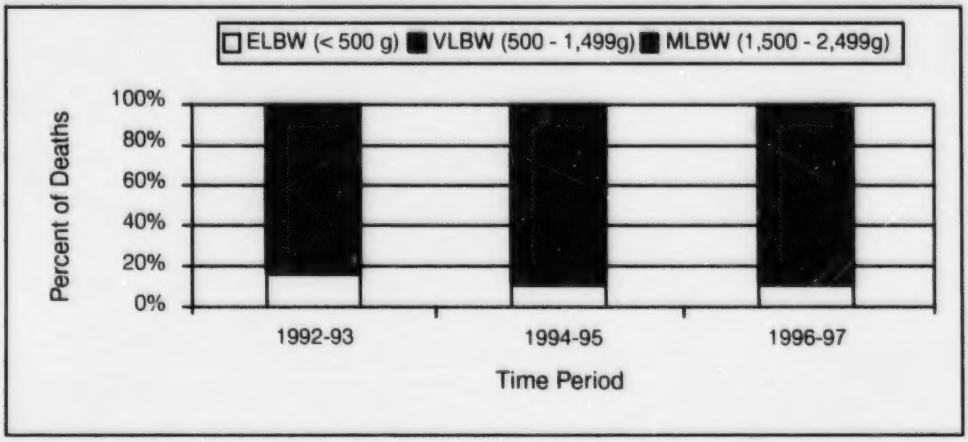
Between 1992 and 1997, 89% of infant deaths were singleton births. Among the 71 infant deaths that were multiple births, 92% were twins. Almost all (97%) of the infant deaths among multiple births were pre-term. The most common causes of death noted for multiple births were conditions arising in the perinatal period (65%), followed by congenital anomalies (17%).

**Birth Weight**

The mean birth weight of all infants who died between 1992 and 1997 was 2,142 grams (std. dev. = 1,265 grams), with a range of 4,978 grams. While there was a high degree of variability in the birth weight recorded for infant deaths, the majority of infants (53%) who died in this six-year period were of Low Birth Weight (LBW). Only 6% were High Birth Weight (HBW) babies.

There were slight changes in the proportion of LBW infant deaths across time; in 1992, 46% of deaths were of low weight, compared to 54% in 1995 and 52% in 1997. Figure 18 illustrates changes in the proportion of Moderately Low Birth Weight (MLBW), Very Low Birth Weight (VLBW), and Extremely Low Birth Weight (ELBW) infant deaths across time.

**Figure 18: Low Birth Weight Infant Deaths, 1992-1997**




As expected, there was a strong positive association between birth weight and length of gestation; the correlation coefficient was .89, indicating that birth weight could be almost entirely predicted from length of gestation, or vice versa. Overall, 90% of pre-term infants who died during the first year of life were LBW babies, while only 14% of infants who were carried to full term and subsequently died in the first year of life were LBW babies.

As a result of this association, birth weight of infants who died in the first year of life also varied as a function of maternal age (see Table 7). More than two thirds (69%) of infant deaths occurring among women ages 35 years and older were LBW babies. In contrast, only 44% of infant deaths occurring among adolescents were of LBW.

**Table 7: Number of Infant Deaths by Maternal Age and Birth Weight, 1992-1997**

| | *under 20 years* | *20-24 years* | *25-29 years* | *30-34 years* | *35 year or older* |
|---|---|---|---|---|---|
| *LBW (< 2500 g)* | 45 | 68 | 73 | 52 | 25 |
| *Normal Weight (2500-4000g)* | 50 | 66 | 47 | 22 | 8 |
| *HBW (> 4000 g)* | 7 | 10 | 6 | 5 | 3 |
| *Total* | 102 | 144 | 126 | 79 | 36 |

There was also a strong association between birth weight and cause of death. During this six-year period, 91% of infant deaths due to RDS and 77% of infant deaths due to perinatal conditions were LBW. In addition, 59% of deaths due to congenital anomalies were LBW. Among those infants who died due to unintentional or intentional injuries, 68% were normal birth weight. Three quarters of infant deaths attributed to SIDS occurred to normal birth weight infants. Finally, 63% of all deaths that were coded as *Other* occurred among normal weight infants, and another 20% were attributed to MLBW infants.

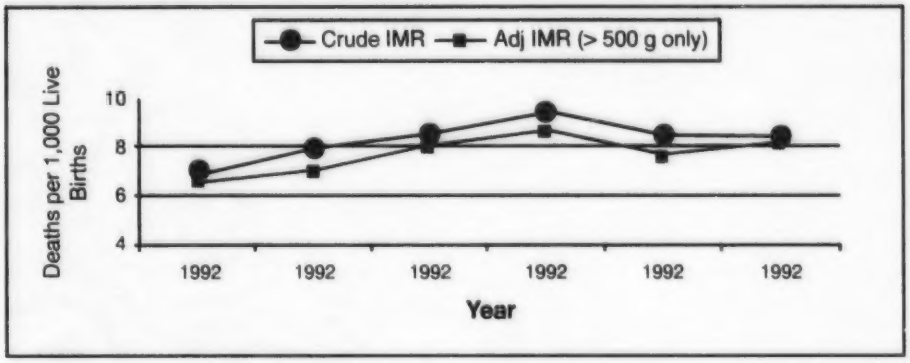
Birth weight among infants who died during the first year of life also varied as a function of Registered Indian status. The mean birth weight for Registered Indian infant deaths was 2,596 grams (std. dev. = 1,183 grams), while for the remainder of infant deaths it was 1,907 grams (std. dev. = 1,243 grams); this difference is statistically significant. Less than one quarter (23.3%) of LBW infant deaths occurred in Registered Indians. More than half of Registered Indian infant deaths (54%) were of normal birth weight, compared to only 32% of infant deaths in the rest of the Saskatchewan population.

**Birth Weight Adjusted Infant Mortality Rates**

Annual infant mortality rates were re-calculated for the period from 1992 to 1997 after excluding all live births in which the recorded birth weight was less than 500 grams. To do this, the number of ELBW infants was removed from both the numerator and the denominator of the rate calculations. In other studies, it has been estimated that 97% of those infants weighing less than 500 grams at birth will die[13]. In fact, for this six-year period, 92% of Saskatchewan infants with a birth weight of less than 500 grams died.

Annual IMRs adjusted for ELBW decreased slightly in comparison with un-adjusted rates, although the magnitude of this decrease was not consistent across time (see Figure 19). The crude infant morality rate for this entire period was 8.2 per 1,000 live births, while the adjusted rate was 7.6 per 1,000.

**Figure 19: Crude and Adjusted IMR for Saskatchewan, 1992-1997**




## Analysis of Regional Differences

### Infant Mortality Rates for Saskatchewan Health Districts/Authority

Table 8 provides numbers of infant deaths occurring in each health district/authority in Saskatchewan for the period from 1982 to 1996. Data are reported in five-year aggregates. As well, district/authority-specific infant mortality rates are given for the most recent five-year period, from 1992 to 1996.

Most health districts/authority experienced a decrease in the number of infant deaths across this 15-year period. Some districts, such as Regina Health District, experienced a substantial decrease in the number of deaths (207 in 1982-1986 to 120 in 1992-1996). For Saskatoon Health District an overall decrease was observed between 1982-1986 and 1992-1996, but a moderate increase was observed between 1987-1991 and 1992-1996.

Rates varied significantly across health districts/authority for the most recent period of the study. Athabasca Health Authority and Mamewetan Churchill River Health District both had rates that were more than double the provincial rate of

8.4 deaths per 1,000 live births. Greenhead Health District has the highest infant mortality rate among all of the southern health districts, 13.0 deaths per 1,000.

Using a test of statistical significance (with 95% confidence intervals) to compare district/authority rates to the provincial rate[17], it was observed that there were seven health districts in which IMRs were significantly different from the overall provincial rate

for this time period. Mamawetan Churchill River Health District had a rate that was significantly higher than the provincial rate, while Central Plains Health District, Midwest Health District, Moose JawThunder Creek Health District, North-East Health District, Pipestone Health District, and Rolling Hills Health District had rates which were significantly lower than the provincial rate. It should be noted that small numbers of deaths across health districts/authority for this time period resulted in large confidence intervals for several district/authority rates. This reduced the statistical power to detect statistically significant differences.

M121

IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES

THE PAGES WHICH FOLLOW HAVE BEEN FILMED TWICE IN ORDER TO OBTAIN THE BEST REPRODUCTIVE QUALITY

USERS SHOULD CONSULT ALL THE PAGES REPRODUCED ON THE FICHE IN ORDER TO OBTAIN A COMPLETE READING OF THE TEXT.

REMARQUE IMPORTANTE CONCERNANT LES PAGES QUI SUIVENT

LES PAGES SUIVANTES ONT ÉTÉ REPRODUITES EN DOUBLE AFIN D'AMÉLIORER LA QUALITÉ DE REPRODUCTION

LES UTILISATEURS DOIVENT CONSULTER TOUTES LES PAGES REPRODUITES SUR LA FICHE AFIN D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL

micromedia
a division of IHS Canada

20 Victoria Street
Toronto, Ontario M5C 2N8
Tel.: (416) 362-5211
Toll Free: 1-800-387-2689
Fax: (416) 362-6161
Email: info@micromedia.on.ca

**Table 8: Number of Infant Deaths for Saskatchewan Health Districts, 1982-1996**

| DISTRICT | 1982-1986 | 1987-1991 | 1992-1996 | IMR (1992-96) | Standard Error (1992-96) |
|---|---|---|---|---|---|
| Assiniboine Valley Health District | 16 | 11 | 7 | 8.5 | 3.2 |
| Athabasca Health Authority | 10 | 6 | 7 | 20.6 | 7.7 |
| Battlefords Health District | 32 | 26 | 13 | 6.8 | 1.9 |
| Central Plains Health District | 16 | 7 | 5 | 4.3* | 1.9 |
| East Central Health District | 18 | 13 | 10 | 6.4 | 2.0 |
| Gabriel Springs Health District | 9 | — | 7 | 8.7 | 3.3 |
| Greenhead Health District | 11 | 6 | 12 | 13.0 | 3.7 |
| Keewatin Yathe Health District | 11 | 16 | 13 | 11.7 | 3.2 |
| Living Sky Health District | 10 | — | — | 4.4 | 2.6 |
| Lloydminster Health District | 7 | 11 | 9 | 9.0 | 3.0 |
| Mamawetan Churchill River Health District | 43 | 32 | 34 | 19.0* | 3.2 |
| Midwest Health District | 18 | 13 | — | 2.1* | 1.5 |
| Moose Jaw/Thunder Creek Health District | 47 | 29 | 10 | 3.5* | 1.1 |
| Moose Mountain Health District | 16 | 9 | 7 | 10.3 | 3.9 |
| North Central Health District | 10 | 7 | 5 | 6.2 | 2.8 |
| North Valley Health District | 8 | — | — | 4.0 | 2.3 |
| North-East Health District | 15 | 6 | — | 4.1* | 2.0 |
| Northwest Health District | 14 | 10 | 16 | 12.4 | 3.1 |
| Parkland Health District | 25 | 21 | 17 | 11.4 | 2.8 |
| Pasquia Health District | 14 | 12 | 12 | 11.7 | 3.4 |
| Pipestone Health District | 12 | 5 | 5 | 4.4* | 2.0 |
| Prairie West Health District | 13 | 6 | 10 | 10.6 | 3.3 |
| Prince Albert Health District | 30 | 57 | 50 | 11.4 | 1.6 |
| Regina Health District | 207 | 168 | 120 | 8.4 | 0.8 |
| Rolling Hills Health District | 9 | 5 | — | 2.9* | 2.1 |
| Saskatoon Health District | 149 | 111 | 144 | 8.6 | 0.7 |
| South Central Health District | 23 | 10 | 12 | 10.1 | 2.9 |
| South Country Health District | 9 | — | — | 4.8 | 2.7 |
| South East Health District | 20 | 17 | 6 | 4.9 | 2.0 |
| Southwest Health District | 11 | 8 | — | 3.9 | 2.8 |
| Swift Current Health District | 13 | 13 | 7 | 5.9 | 2.2 |
| Touchwood Qu'Appelle Health District | 7 | 11 | 7 | 7.2 | 2.7 |
| Twin Rivers Health District | 20 | 11 | 11 | 8.6 | 2.6 |
| Grand Total | 873 | 665 | 575 | 8.4 | 0.4 |

Note: Numbers less than 5 have been removed for purposes of confidentiality of information.

* = IMR which is significantly higher/lower than the provincial rate for the period from 1992-1996.

**Table 8: Number of Infant Deaths for Saskatchewan Health Districts, 1982-1996**

| DISTRICT | 1982-1986 | 1987-1991 | 1992-1996 | IMR (1992-96) | Standard Error (1992-96) |
|---|---|---|---|---|---|
| Assiniboine Valley Health District | 16 | 11 | 7 | 8.5 | 3.2 |
| Athabasca Health Authority | 10 | 6 | 7 | 20.6 | 7.7 |
| Battlefords Health District | 32 | 26 | 13 | 6.8 | 1.9 |
| Central Plains Health District | 16 | 7 | 5 | 4.3* | 1.9 |
| East Central Health District | 18 | 13 | 10 | 6.4 | 2.0 |
| Gabriel Springs Health District | 9 | — | 7 | 8.7 | 3.3 |
| Greenhead Health District | 11 | 6 | 12 | 13.0 | 3.7 |
| Keewatin Yathe Health District | 11 | 16 | 13 | 11.7 | 3.2 |
| Living Sky Health District | 10 | — | — | 4.4 | 2.6 |
| Lloydminster Health District | 7 | 11 | 9 | 9.0 | 3.0 |
| Mamawetan Churchill River Health District | 43 | 32 | 34 | 19.0* | 3.2 |
| Midwest Health District | 18 | 13 | — | 2.1* | 1.5 |
| Moose Jaw/Thunder Creek Health District | 47 | 29 | 10 | 3.5* | 1.1 |
| Moose Mountain Health District | 16 | 9 | 7 | 10.3 | 3.9 |
| North Central Health District | 10 | 7 | 5 | 6.2 | 2.8 |
| North Valley Health District | 8 | — | — | 4.0 | 2.3 |
| North-East Health District | 15 | 6 | — | 4.1* | 2.0 |
| Northwest Health District | 14 | 10 | 16 | 12.4 | 3.1 |
| Parkland Health District | 25 | 21 | 17 | 11.4 | 2.8 |
| Pasquia Health District | 14 | 12 | 12 | 11.7 | 3.4 |
| Pipestone Health District | 12 | 5 | 5 | 4.4* | 2.0 |
| Prairie West Health District | 13 | 6 | 10 | 10.6 | 3.3 |
| Prince Albert Health District | 30 | 57 | 50 | 11.4 | 1.6 |
| Regina Health District | 207 | 168 | 120 | 8.4 | 0.8 |
| Rolling Hills Health District | 9 | 5 | — | 2.9* | 2.1 |
| Saskatoon Health District | 149 | 111 | 144 | 8.6 | 0.7 |
| South Central Health District | 23 | 10 | 12 | 10.1 | 2.9 |
| South Country Health District | 9 | — | — | 4.8 | 2.7 |
| South East Health District | 20 | 17 | 6 | 4.9 | 2.0 |
| Southwest Health District | 11 | 8 | — | 3.9 | 2.8 |
| Swift Current Health District | 13 | 13 | 7 | 5.9 | 2.2 |
| Touchwood Qu'Appelle Health District | 7 | 11 | 7 | 7.2 | 2.7 |
| Twin Rivers Health District | 20 | 11 | 11 | 8.6 | 2.6 |
| Grand Total | 873 | 665 | 575 | 8.4 | 0.4 |

Note: Numbers less than 5 have been removed for purposes of confidentiality of information.

* = IMR which is significantly higher/lower than the provincial rate for the period from 1992-1996.

**Regina and Saskatoon Comparisons**

To further investigate regional differences in infant mortality, several analyses were conducted to examine the extent to which maternal and infant characteristics associated with infant death varied across regions of the province. This investigation was conducted for the period from 1992 to 1997, using information contained on both the birth and death registrations.

The first of these regional analyses focussed on the urban centres of Regina and Saskatoon. In this six-year period, there were 133 infant deaths reported for residents of Regina and 156 deaths reported for residents of Saskatoon.

Infant deaths occurring in these two cities were compared for differences in the following variables: age at death, maternal age, birth weight, and cause of death. A chi-square analysis revealed that there were no significant differences between the two urban centres in terms of causes of death ($c^2 = 2.62$; $p = 0.76$; $df = 5$). For the other variables of age at death, maternal age, and birth weight, ANOVA was used to test for differences. Because of the preceding results, which suggested the differential effect of Registered Indian status, this city analysis was examined through the use of an two-way ANOVA; the independent variables were *city* (Regina, Saskatoon), and *Registered Indian Status* (Registered Indian, other). ANOVA revealed differences between the two centres for age at death ($F = 6.66$; $p = 0.0003$; $df = 3, 277$), maternal age ($F = 4.46$; $p=.0045$; $df = 3, 277$) and birth weight ($F = 9.07$; $p = 0.0001$; $df = 3, 277$). However, for all three analyses the $R^2$ statistics were less than .10, indicating that the magnitude of the differences were small. Table 9 provides information on mean age at death, maternal age, and birth weight for these two variables.

**Table 9: Birth Weight by City and Registered Indian Status, 1992-1997**

| | *Regina* | | *Saskatoon* | |
|---|---|---|---|---|
| | *Registered Indians* | *Other* | *Registered Indians* | *Other* |
| *N* | 22 | 109 | 39 | 111 |
| ***Age at Death (days)*** | | | | |
| *Mean* | 81 | 47 | 98 | 35 |
| *SD* | 97 | 80.5 | 99 | 74 |
| ***Maternal Age (years)*** | | | | |
| *Mean* | 25 | 27 | 24 | 27 |
| *SD* | 5.9 | 5.4 | 5.3 | 5.9 |
| ***Birth Weight (grams)*** | | | | |
| *Mean* | 2589 | 1912 | 2765 | 1735 |
| *SD* | 1087 | 1252 | 1070 | 1205 |

Registered Indian infants who were residents of Regina tended to die at younger ages, to weigh less, and to be born to slightly older mothers than their counterparts in Saskatoon. All other infants tended to be die at older ages and to weigh more if they were residents of Regina as opposed to residents of Saskatoon. Again, however, the differences are not large, and the finding of statistically significant results may be, in part, influenced by the differences in the number of observations (*N*) for each cell of the analysis.

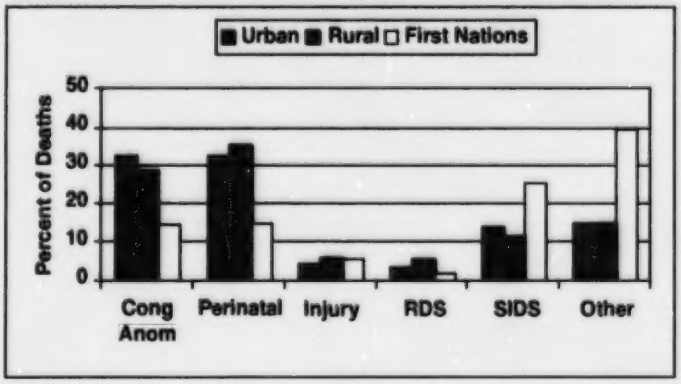
**Rural, Urban, and First Nations Comparisons**

The second of the regional analyses focussed on infant deaths occurring in urban centres in Saskatchewan (excluding Regina and Saskatoon), rural Saskatchewan, and First Nations. Infant deaths occurring in these three regions of the province were compared for differences with respect to the following variables: age at death, maternal age, birth weight, and cause of death. Because the vast majority of those infant deaths occurring on First Nations were for Registered Indians, ethnicity was not included as a covariate in these analyses. For the period from 1992 to 1997, there were 204 infant deaths occurring to residents of urban areas, 133 infant deaths occurring to residents of rural areas, and 56 infant deaths occurring to residents of First Nations.

An ANOVA revealed that there were significant differences among the three regions for age at death (F=3.64; p = .001; df=2, 390), although the $R^2$ value for this analysis was .02, indicating that the relationship was weak. For First Nations residents, the mean age at death was 86 days, compared to 61.5 days for rural residents and 52 days for urban residents. In other words, First Nations infant deaths tended to occur at slightly older ages.

A chi-square analysis revealed that there were also significant differences among the three regions with respect to cause of death ($c^2$=34.8; p = 0.001; contingency coefficient = 0.29). Figure 20 reveals that congenital anomalies and perinatal conditions were less common causes of death for First Nations infant deaths than were SIDS and other causes of death.

**Figure 20: Causes of Infant Death by Region, 1992-1997**



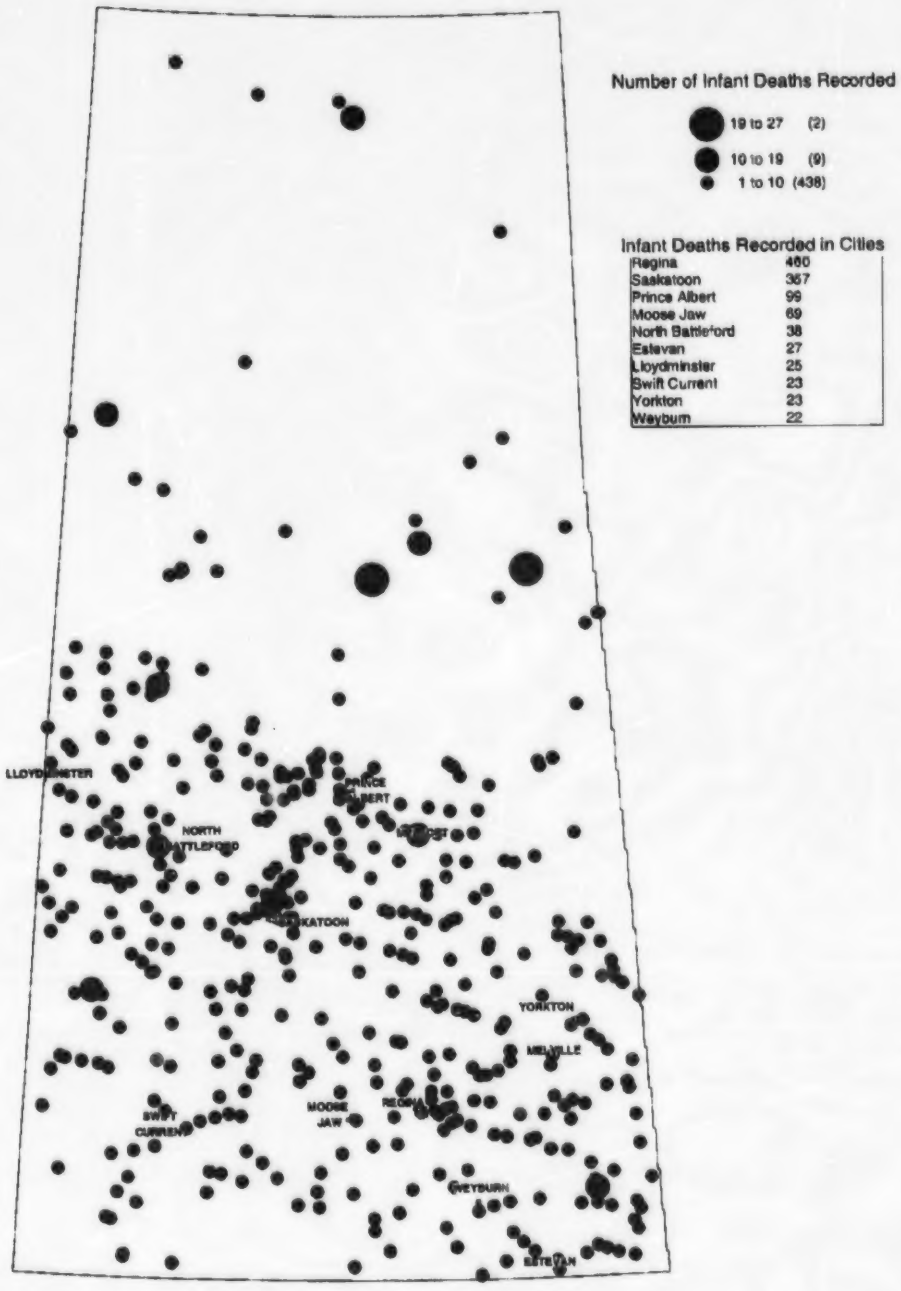

ANOVA revealed that there was a statistically significant difference among the three regions in terms of birth weight (F = 6.40; p = 0.002; df = 2, 374), although the proportion of variation in the outcome variable which was explained by region of residence ($R^2$ = .03) was very small. ANOVA revealed that there were no significant differences between the three regions with respect to maternal age (F = 2.83; p = 0.06; df = 2, 374). With respect to birth weight, First Nations infant deaths tended to be of

higher birth weight, with a mean of 2,806 grams (std. dev. = 1,053 grams), as compared with urban infant deaths (mean = 2,190grams; std. dev = 1,272 grams) or rural infant deaths (mean = 2,078 grams; std. dev. = 1,295 grams).

**Community of Residence**

The community of residence of infants who died during the entire fifteen-year period of the study was mapped (see Figure 21). Clusters of infant deaths across the province are evident. There are large clusters (19-27 infant deaths/community) scattered across northern Saskatchewan. These clusters appear to be linked to the population distribution in the north. Clusters of infant death are also located throughout southern Saskatchewan. Some of these clusters of infant deaths (or areas with no infant deaths) appear to be linked to population density (i.e. southwestern Saskatchewan).

**Figure 21: Infant Deaths by Community of Residence, Saskatchewan, 1982-1996.**



# DISCUSSION AND CONCLUSIONS

The main intent of this report was to describe trends in the numbers and types of infant deaths in Saskatchewan for the 15-year period from 1982 to 1996. To this end, data were compiled from the vital statistics registry maintained by the province of Saskatchewan. Both death and birth records were used in preparing the report.

It is useful, at the outset of this section, to consider both the limitations and strengths of the data presented here and the analyses which have been conducted. The vital statistics registry system is a comprehensive system that covers the entire provincial population. The registry contains information on a number of variables that are important for analyzing variations in infant deaths, including sex of infant, infant's age at the time of death, season of death, cause of death, birth weight, maternal age, length of gestation, type of birth, and residence location. However, it is also clear from the analyses conducted that the data fields maintained in the registry do not afford the ability to completely describe variations in the numbers and types of infant deaths occurring in Saskatchewan. Other potential risk factors that might be studied in the context of infant mortality include socio-economic status, assisted reproduction, environmental factors, maternal prenatal health, and characteristics of labour and delivery.

As well, the pathways of relationships among the registry variables that were investigated are not clear from the information available for analysis. For example, the data suggest that Registered Indian infants tend to have higher rates of death due to SIDS than the rest of the provincial infant population. However, it is not known what underlying factors contribute to this difference. They may be the result of differences in the physical environments in which infants are raised, or they may be a function of differences in reporting mechanisms. Because a single person does not maintain the registry, differences are likely to exist in the manner in which data are reported and recorded. Millar and Hill[17], who investigated SIDS deaths in Canada between 1979 and 1988, suggest that variations do exist in the way that a death is reported; some deaths due to accidental suffocation may be inadvertently attributed to SIDS.

A number of concerns regarding data quality in vital statistics registries in Canada arose after one study[10] identified a problem associated with the recording of birth weight in Ontario's vital statistics registry. However, this is an isolated incident; all registries conduct investigations

of the quality of both data coding and reporting to ensure that the number of errors are minimized.

Despite these potential difficulties, the use of the vital statistics registry as a tool for investigating infant mortality trends and characteristics has a number of obvious strengths. First, population-based data are available across time using a standard venue for data collection and consistent terminology for identifying infant births and deaths; this methodology is also consistent across Canada, enabling reliable comparisons across provincial/territorial jurisdictions. The availability of the registry data allows for continued surveillance, using basic infant, maternal, and geographic information to describe numbers and types of infant deaths.

The development of a methodology for merging Saskatchewan birth and death registrations is also an important contribution of this study. The use of birth information to describe and compare infant deaths facilitates an understanding of the characteristics of infant deaths in Saskatchewan.

It is apparent from the data that crude IMRs in Saskatchewan have shown a fairly substantial decline since 1982. The largest reductions in rates were found prior to 1992. Since that time, there has been some fluctuation in IMRs, with small increases noted in 1993 and 1995. Studies have indicated that the infant mortality rate in most industrialized countries, including Canada, has decreased in the last century, but at a slower rate in recent years. This slower rate of decline in infant mortality rates may be a result of progress in perinatal care. Pregnancies that previously would have ended in miscarriage or stillbirth are resulting in low birthweight births with precarious survival chances. Kramer and Joseph[10] studied the increase in Canadian infant mortality in 1994 and suggested that the increase in the proportion of low birth weight newborns helped to explain the possible deterioration in maternal, fetal, or infant health.

Rates were significantly higher among the Registered Indian population than the non-Registered Indian population or the Saskatchewan population as a whole. In 1997, this difference increased substantially and future monitoring of these rates will determine if this widening gap becomes a trend. Nationally, rates among Registered Indians were twice that of the Canadian population as a whole in 1994[7].

Joseph and Kramer[9, 10] showed that the increase in the Canadian infant mortality rate in 1993 was explained by a simultaneous increase in the registration of newborns weighing less than 500 grams as live births. In fact, after adjusting for this birth weight category, they found

that the IMR decreased between 1987 and 1993. Infant mortality rates in this study were similarly re-calculated after removal of newborns weighing less than 500 grams. After this adjustment, the rate in all years decreased by a modest amount.

As this study reveals, an infant's age at death, length of gestation, birth weight, and cause of death are inextricably linked factors. Length of gestation and birth weight are very highly correlated factors. As well, low-weight infant deaths tended to occur among younger infants, and were typically the result of conditions arising in the perinatal period. In this study, half of all low-birth-weight infant deaths were attributed to perinatal conditions. This particular cause-of-death category is a conglomerate of health problems that may affect the mother, the newborn, or both. While this category represents a substantial proportion of infant deaths, it has little value for understanding preventable causes of death[18]. Because of this, a number of studies have suggested new methodologies for coding causes of death in order to focus attention on preventable causes. For example, a new classification scheme for causes of death might focus on the increasing proportion of deaths that are attributable to prematurity[19]; less attention might be given toward infectious causes of death, because these now account for a small and decreasing proportion of all infant deaths[11]. The ICD-10 classification system, which will be implemented in Canadian vital statistics registries beginning January 1, 2001, may help to focus on causes of death which are more specific in nature.

This report also suggests that the identification of commonalties in infant deaths depends, at least in part, on whether or not an infant was a Registered Indian. A number of the analyses conducted suggest that there are substantial differences between Registered Indian infant deaths and infant deaths occurring among other members of the Saskatchewan population. Registered Indian infant deaths tend to occur among younger mothers, have higher birth weights, are less likely to occur in the early days of life, and are more likely to be the result of congenital anomalies, other conditions, or SIDS. On the other hand, infant deaths occurring among the rest of the Saskatchewan population tend to occur to older mothers and are associated with lower birth weights. They are more likely to occur in the early days of life, and are more likely to be due to conditions arising in the perinatal period or to congenital anomalies. This finding may at least partially support the conclusion of a recent study[20] that birth weight (and length of gestation) might best be treated as a confounding variable in the analysis of infant deaths, rather than variables of primary interest. A focus on birth weight, and characteristics of infant

mortality known to be highly correlated with birth weight, may actually draw attention away from important differences in infant mortality across different segments of the population.

There are a wide variety of programs and services that can contribute to infant health including prenatal care, neonatal intensive care, health education, family planning services, smoking cessation programs, income support programs, and prenatal nutrition counselling and support. Provincial initiatives such as the Child Death Review Committee, Saskatchewan's Action Plan for Children, the Early Childhood Development Strategy, and the National Children's Agenda are also making contributions to improved health and wellbeing for infants. This analysis of data on infant deaths in Saskatchewan is one step towards an increased awareness of the complexity of factors that contribute to infant health and the need to continue efforts to monitor those programs and initiatives that may impact on infant health. It is hoped that this study will help to draw attention to the opportunities for prevention that do exist within the province.

## REFERENCES


1. Joseph KS. Recent trends in Canadian infant mortality rates: effect of changes in registration of live new-borns weighing less than 500g. *Canadian Medical Association Journal* 1996: 155(8) 1047-1052.

2. Kerr G, Ying J, and Spears W. Searching for preventable causes of infant mortality in Texas. *Texas Medicine* 1997: 93 (1) 81-88.

3. Nault F. Infant mortality and low birthweight, 1975 to 1995. *Health Reports* 1997: 9(3): 40-45.

4. Petrini J, Damus K, and Johnston R. An overview of infant mortality and birth defects in the United States. 1997: March of Dimes Birth Defects Foundation.

5. Centres for Disease Control. Poverty and infant mortality – United States, 1988. *MMMWR* 1995: 44(49): 922-923.

6. SinghY, Gopal K and Yu SM. Infant mortality in the United States: trends, differentials, and projections, 1950 through 2010. *American Journal of Public Health* 1995: 85(7), 957-64.

7. Federal, Provincial, and Territorial Advisory Committee on Population Health. T*oward a healthy future: Second report on the health of Canadians*, 1999, Ottawa.

8. Statistics Canada, Health Statistics at a Glance, 1999: Catalogue Number: 82F0075XCB, Ottawa.

9. Joseph KS and Kramer MS. Canadian infant mortality: 1994 update [letter]. *Canadian Medical Association Journal 1997*; 156(2): 161-163.

10. Joseph KS and Kramer MS. Recent trends in infant mortality rates and proportions of low birth-weight live births in Canada. *Canadian Medical Association Journal 1997*: 157(5): 535-541.

11. Gessner BD and Wickizer TM. The contribution of infectious diseases to infant mortality in Alaska. *The Paediatric Infectious Disease Journal 1997*: 16(8): 773-779.

12. SAS [Computer software]. (1989-1996). North Carolina: SAS Institute Incorporated.

13. Svenson LW, Schopflocher DP, Sauve RS and Robertson CMT. Alberta's infant mortality rate: the effect of the registration of live newborns weighing less than 500 grams. *Canadian Journal of Public Health 1998*; 89 (3): 188-189.

14. Cohen, J. *Statistical power analysis for the behavioral sciences*, 2nd ed. 1988. Hillsdale, NJ: Erlbaum.

15. Carriere KC and Roos LL. Comparing standardized rates of events. *American Journal of Epidemiology* 1994: 104(5): 472-482.

16. Carmichael SL, Iyasu S. Changes in the Black-White infant mortality gap from 1983 to 1991 in the United States. *American Journal of Preventative Medicine 1998*: 15(3): 220-227.

17. Millar, WJ, Hill, GB. Prevalence of and risk factors for sudden infant death syndrome in Canada. *Canadian Medical Association Journal 1993*: 149: 629-635.

18. Dollfus C, Patetta M, Siegel E, Cross AW. Infant mortality: A practical approach to the analysis of the leading causes of death and risk factors. *Pediatrics 1990:* 86: 176-183.

19. Sowards KA. What is the leading cause of infant mortality? A note on the interpretation of official statistics. *American Journal of Public Health 1999:* 89: 1752-1754.

20. Hertz-Picciotto I, Din-Dzietham R. Comparisons of infant mortality using a percentile-based method of standardization for birthweight or gestational age. *Epidemiology 1998:* 9(1): 61-66.

## Appendix: Causes of Infant Death

**Congenital Anomalies**

**ICD-9:** 740-759

**Description**: Congenital anomalies are a group of conditions present at birth. Included in this category are chromosomal anomalies such as Down's syndrome, heart, lung, and brain defects. Congenital anomalies may be inherited or acquired; inheritance or acquisition may occur during the gestation period or during delivery. Acquired defects are generally the result of intrauterine conditions influenced by maternal factors such as the use of alcohol, antibiotics, or other drugs.

**Conditions Arising in the Perinatal Period**

**ICD-9:** 760-768, 770-779

**Description**: Conditions in this category may originate in the perinatal period, even though death may occur later. This category includes complications of the placenta, umbilical cord, or membranes. Other conditions such as the length of the gestation period and birth weight, intrauterine hypoxia, and birth asphyxia are included.

**Respiratory Distress Syndrome (RDS)**

**ICD-9:** 769

**Description:** RDS is a condition that occurs most often among infants born before the 37$^{th}$ week of gestation or who weight less than 2200 grams (5 lbs.) at birth. Surfactant, which is produced in the alveoli or air sacs of the lungs, is lacking in premature infants. This substance is necessary to move air in and out of the lungs, and is not produced until shortly before birth, normally around 40 weeks after conception.

**Sudden Infant Death Syndrome (SIDS)**

**ICD-9:** 798.0

**Description:** SIDS occurs without warning in otherwise healthy infants for reasons not completely understood.

**Unintentional and Intentional Injuries**

**ICD-9:** 800-999

**Description:** This category includes bodily harm resulting in death that occurs because of such incidents as falls, poisoning, drowning, burns, choking, or motor vehicle accidents. Intentional injuries such as homicide are included in this category.

**Other**

**ICD-9:** 001-739, 780-797, 799

**Description:** This category covers all other conditions not mentioned above, including infectious and parasitic disease, cancer, and conditions of the respiratory system, including cardio-pulmonary arrest.

ISBN 1-55157-009-2